

Space Weather Effects

Time:

4 hours

Objective:

Using the Internet, students will investigate some of the other effects of space weather. This lesson is designed to present an overview of some of the effects of space weather. It is also designed to allow students to use the data and information they gain to present a Space Weather forecast. This lesson will work best if groups of 4-5 students are formed.



Content Standards:

Meets National Science Education Standards:

- Science as Inquiry
 - abilities necessary to do scientific inquiry
- Earth and Space Science
 - earth in the solar system
- Science and Technology
 - understandings about science and technology

Equipment, Materials, and Tools:

- Pencils/pens
- Notebook paper
- One computer per student
- Access to Internet

Materials to reproduce

- Space Weather Effects worksheet
1 copy per group

Prerequisite Skills:

Internet navigation skills

Background Information:

Although the interplanetary medium between the Sun and the planets was once considered a perfect vacuum, we now know that it is actually a turbulent region dominated by the solar wind. Changing conditions on the Sun affects the characteristics of the interplanetary medium and its effect on bodies that the solar winds encounter.

As the solar wind flows around obstacles it too is affected by magnetic field lines such as those created by the Earth's magnetic core. Under the influence of the solar wind, the Earth's magnetic field lines are compressed on the solar side and stretched on the downwind side, the Earth's magnetosphere. The interface between interplanetary space and the Earth's magnetosphere is very dynamic. As the magnetosphere extracts energy from the solar wind particles, internal processes produce major terrestrial results such as aurora, proton events, and geomagnetic storms.

Solar wind particles entering the Earth's upper atmosphere strike the molecules of the thin atmosphere transferring energy and giving off a glow of different colors. Although beautiful, the aurora created by the energized solar wind particles are a visible sign of atmospheric changes that can wreak havoc on modern technological systems.

Energetic protons sloughed off during major solar flares can reach the Earth within 30 minutes. These protons can shower the Earth, spiraling down to the Earth's magnetic field lines, penetrating the upper atmosphere and producing additional ionization that can produce significant increases in the level of radiation in the environment.

These geomagnetic storms can have dire effects on modern communication systems utilizing the ionosphere to reflect radio signals from one location on the Earth to countless others. Ionospheric storms can affect radio communication at all latitudes by causing rapid fluctuating signals and unexpected propagation paths. High frequency communications disrupted include: ground-to-air, ship-to-shore, Voice of America, Radio Free Europe, and amateur radio. High frequency operations rely upon solar and geomagnetic alerts to keep their circuits running. In addition, some military early-warning and detection systems can be affected, as can aircraft communications. It is important that operators of these types of systems receive alerts of a proton or geomagnetic storms in progress so they can switch to backup systems thus protecting their main systems.

Geomagnetic storms can also cause the orbits of satellites to change as the Earth's upper atmosphere is heated by solar particles, causing it to rise and increase the density at the satellites orbital path. The increased density produces increased drag causing the satellites to slow down and change orbit slightly. Miniaturized instrumentation and communication systems on spacecraft are highly susceptible to energetic solar particles.

Humans in space are also susceptible to highly energetic particles. Although we are protected on the surface by the Earth's atmosphere and magnetosphere, astronauts (and cosmonauts) can be subjected to lethal doses of radiation. Taking a space walk during a geomagnetic storm is a high-risk adventure and not recommended.

Geomagnetic storms can generate nearly direct current flow across conductors normally transmitting alternating currents. These direct currents are harmful to electrical transmission lines and can cause wide spread electrical outages. Fluctuating geomagnetic fields can induce currents in pipelines causing transmission of erroneous flow information and even increasing the corrosion rate of the pipeline itself. The result can be catastrophic leaks.

We have only begun to realize the affect that magnetic storms have on our daily lives. As our technological expertise advances, and our dependence on technology grow, the list of consequences grows proportionally. Thus there will be a need for continuing our efforts to understand our space environment.

Visit these links to find out about the other effects that space weather has on Earth:

<http://www.sel.noaa.gov/primer/primer.html>

<http://www.sel.noaa.gov/Education/>

<http://www.sel.noaa.gov/Data/>

Lesson Plan:

1. Provide 5-10 minutes for a brainstorm session with students about some of the other effects (besides auroras) that space weather might have on earth. Make sure to write students' answers on an overhead/board.
2. Handout the *Space Weather Effects* worksheet to every group.
3. Direct students to <http://www.sel.noaa.gov/Education/> to begin this lesson.
4. Students are to investigate the website to find out more about the effects of Space Weather and to complete the worksheet.
5. Students should also focus on the data that helps monitor and predict Space Weather.
6. After students have completed the worksheet, allow time to discuss their findings in a large group setting.

Assessment:

1. In groups or individually, students will produce a simulated newscast for the evening news that discusses today's Space Weather and forecasts the following week's Space Weather. To prevent duplicity you might want to assign specific dates for each group's newscast.
2. Students should follow a news channel's weather format to create their newscast. Assign each group a news channel to watch at home to find out what type of format is used. Each group should have a script to work from and they should also provide pictures and/or videos to accompany the forecast.
3. Students will need to talk about the forecast in terms of the effect that it will have on Earth, if any. If there are no predicted effects on Earth for that day or week then that should be mentioned in the broadcast.
4. The following site has links to other Space Weather web-sites for students to find out information for their project:
 - <http://www.sel.noaa.gov/sources.html>

Assessment Criteria:

- Every group member has contributed to the newscast.
- Newscast follows a news channel's format.
- Information about Space Weather forecast is accurate.
- Script and pictures are used in presentation.
- Students talk about how the Space Weather forecast will impact the Earth.

Space Weather – Student Worksheet

Name: _____ Period: _____ Date: _____

1. What types of systems on Earth does Space Weather affect?
2. How do these systems relate to the functioning of our society? How are you affected individually?
3. What types of Space Weather warnings are in effect for today? This week? This month?
4. What types of satellites monitor Space Weather?
5. Identify one Space Weather satellite that is currently in use. What instruments are used on that satellite to collect data on Space Weather? What type of data do the instruments collect?